USDA FOREST SERVICE

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NORTH CENTRAL FOREST EXPERIMENT STATION, FOREST SERVICE—U.S. DEPARTMENT OF AGRICULTURE

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SOME FOREST FLOOR FUELBED CHARACTERISTICS OF BLACK OAK STANDS IN SOUTHEAST MISSOURI

ABSTRACT.--Black oak forest floor fuelbeds under 20- and 40-year-old stands in southeast Missouri averaged 6.4 and 8.3 tons per acre and 4.0 and 4.2 inches in depth, respectively. Loose litter averaged 2.0 and 2.9 tons per acre and 3.3 inches in depth. Bulk density of litter averaged 0.33 and 0.49 lb/ft^3 and of total forest floor 0.89 and 1.10 lbs/ft^3, respectively.

OXFORD: 431.2:431.4(778):176.1 *Quercus velutina*. KEY WORDS: forest fuels, black oak, forest fire, fuel models.

Fuel information plays an integral part in the National Fire Danger Rating System (Deeming *et al.* 1972). Although the ratings depend upon fuel models representing broad fuel types, specific fuel information is needed for selecting or building a model. One of the models was designed to accommodate a large part of the 116 million acres of oak-hickory forest of the eastern United States (USDA Forest Service 1965). This is the most extensive general forest type in the country, although there are many variations in species, stocking, and site. Many forest fires occur in this timber type each year, and the ever-present and remarkably uniform forest floor is commonly the dominant fuel component.

Forest floor fuelbed weight, bulk density, and depth in predominantly black oak forest floors in southeast Missouri are reported here.

Total weight of forest floor in 20-year-old stands averaged 6.4 tons per acre, 2.0 of which were loose, fresh litter, mostly leaves. Forty-year-old stands averaged 8.3 tons of forest floor per acre, including 2.9 tons of litter.

Forest floor depth measured to the top of the highest point of uncompressed litter averaged 4.0 inches and 4.2 inches in the 20- and 40-year-old stands; about two-thirds of this depth was loose litter (table 1).

Average litter fuel bulk density was 0.34 and 0.48 lb/ft^3 in the 20- and 40-year-old stands. The much denser fermentation (F) and humus (H) layers averaged 2.61 and 2.47 lbs/ft^3 (table 2). All measurements were significantly greater in stands of older trees.

These weights correspond well with measurements made in Iowa (Kucera 1952), Tennessee (Blow 1955), and South Carolina (Metz 1954) in similar stands, indicating uniform volumes on oak-hickory forest floors over a wide area.

Dead leaves in the forest floor litter of the species common in central hardwood stands contain a large surface area (black oak = 111 cm^2/cm^3 [1/]). The leaves are not subject to much compaction from winter snows, and so maintain a rough, curled, loose fuelbed on top of the more compact F and H layers.

During early spring, when most fires occur in the central hardwood types, the live trees are leafless, permitting maximum exposure to sun and wind. As a result, litter moisture content responds rapidly to the prevailing relative humidity. The F and H layers normally are more

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[1/] *Personal communication with James Brown, Northern Fire Lab., Missoula, Montana.*

Table 1.--*Depth and weight of 20- and 40-year-old black oak forest floors in southeast Missouri*

Layer	Average age (years)			Standard deviation among plot averages (age, years)		
	20	40	20 & 40	20	40	20 & 40
DEPTH (inches)						
L layer						
Maximum[1]	3.25	3.33	3.29	--	--	--
Standard[2]	1.32	1.34	1.33	--	--	--
F and H layers						
Standard	.71	.85	.78	0.10	0.09	0.11
Total (F + L + H)						
Maximum	3.96	4.17	4.07	.50	.50	.55
Standard	2.03	2.18	2.11	.28	.29	.29
Compressed[3]	.74	.92	.83	.13	.15	.17
WEIGHT (tons per acre)						
L layer						
Foliage and fines	1.81	2.34	2.08	.27	.27	.38
Wood <0.6" diameter	.18	.41	.30	.06	.20	.14
Acorns and parts	.01	.15	.08	.01	.07	.09
Other coarse	.01	--	.01	.01	--	--
Total	2.01	2.91	2.47	.29	.37	.56
F layer						
Foliage and fines	2.93	3.29	3.11	.42	.50	.50
Wood <0.6" diameter	.31	.40	.36	.17	.12	.15
Acorns and parts	.01	.09	.05	.01	.05	.05
Other coarse	.12	.03	.07	.52	--	--
Total (L + F)	5.36	6.72	6.05	.86	.65	1.02
H layer						
Humus and roots[4]	.84	1.53	1.19	.26	.33	.46
Punk	.17	.09	.13	.26	--	--
Total (L + F + H + P)	6.37	8.34	7.37	.77	.88	1.29

[1]Maximum depth - mineral soil to tip of highest leaf.
[2]Standard depth - mineral soil to bottom of standard gauge, exerting approximately 0.06 lb/in^2.
[3]Compressed depth - mineral soil to bottom of standard gauge forced down by hand to minimum depth.
[4]Incinerated weight - dry weight less ash and soil.

Table 2.--*Bulk density of black oak forest floor materials*

(lbs/ft^3)

Layer	Stand age (years)		
	20	40	20 & 40
L layer			
Maximum depth	0.33	0.49	0.41
Standard depth	.84	1.20	1.02
F and H layers	2.61	2.47	2.54
L + F + H layers			
Maximum depth	.89	1.10	1.00
Standard depth	1.73	2.11	1.92
Compressed depth	4.73	4.99	4.89

moist and respond much more slowly. This moisture gradient permits some fires to burn the top litter layer, leaving the F and H layers untouched. However, even when these lower layers are dry, some material in them may not burn because the layers may be too dense to be ignited by fast-burning litter.

In contrast to many other kinds of fuelbeds, the oak-hickory forest floor is not usually conducive to high-intensity fires, although fires start easily and spread rapidly under favorable conditions. Fires can develop enough intensity to be difficult to control and to cause many undesirable effects. Fire intensity is usually increased by dead, woody material on the forest floor originating from normal mortality of trees and branches, intermediate harvest cuttings, and trees killed in timber stand improvement operations or by fire.

SOURCE OF DATA

Forest floor fuelbed weight estimates and depth measurements were made on 71 half-acre plots in black oak stands in Dent and Iron Counties of southeast Missouri (fig. 1). Thirty-five stands were 20 years old and 36 were 40 years old. All stands originated from stool sprouts and seedlings following severe fire or cutting and were fully stocked.

Figure 1.--Typical 40-year-old oak-hickory (Black Oak) stand in winter--Southeast Missouri.

Estimated mean weight per acre of forest floor materials was derived for each plot from forty-eight 5-inch-diameter subsamples (fig. 2). The sampling method was determined in advance to yield estimates within 5 percent of the mean with 95 percent confidence limits. Similar material from all subsamples in a plot was pooled for processing.

It is not possible to precisely separate the different forest floor layers, but by careful training and checking of personnel, consistent separations were made. Moreover, the layers in the oak-hickory forest floors are much more distinct than in many other types. Ovendry weight for each layer and for punky wood was obtained separately, but wood more than one-half inch thick was discarded.

Some soil and small stones were included in the H layer. The amount of this heavy material is highly variable in the collections and compromises the results if included in the weight. So to avoid overestimating, all H-layer material was incinerated. The reported weight is the loss in weight by burning. This eliminated the mineral soil but also eliminated the ash weight, which is not deducted from the other layers. The percentage of ash in raw litter is small but increases as the litter decomposes. Thus the error is minor for the younger portions and elimination of ash weight in humus gives a closer estimate of combustible fuel weight for the forest floor as a whole. An average of 56 percent of ovendry weight was discarded in ash and soil.

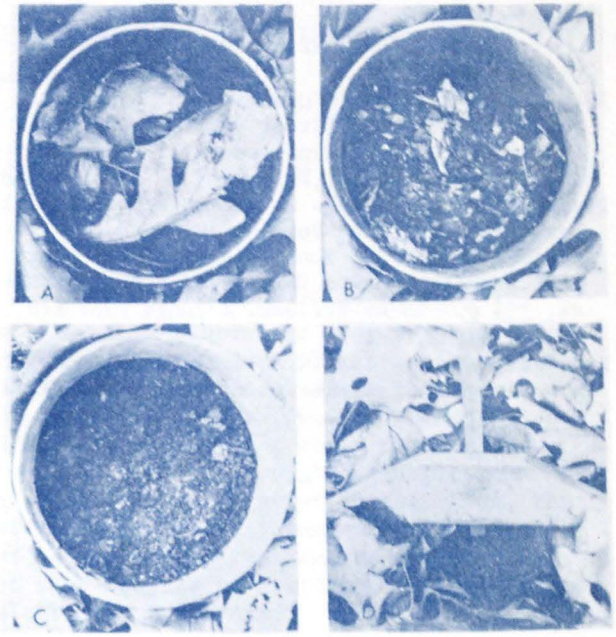

Figure 2.--Forest floor sampling technique: (A) 5-inch diameter sampling cylinder inserted in forest floor (B) litter layer removed (C) litter, fermentation and humus layers removed (D) measuring standard depth of forest floor.

The forest floors, especially those developed from black, post, red, scarlet, and blackjack oaks, can be best described as duff mull humus type, transitional between mull and mor (Soil Science Society of America 1965, Metz 1954).

Depth of total forest floor and of combined F and H layers was measured at each of the 48 subsample points on each plot and averaged for the plot (fig. 2). Total depth was measured twice: once to the top of the highest point of uncompressed litter (the maximum total depth), and again to the base of a measuring gauge resting freely on the litter under approximately 0.06 lb/in^2 pressure (the standard depth). The depth of the F and H layers was measured after removal of the litter. Then, by subtraction, the depth of the L layer was obtained. The difference in depth by the two specifications for measurement illustrate the variation in depth

and density inherent in different methods, and may explain differences found for similar types by different observers (table 1). It was not practical to measure the F and H layer depths separately.

All sampling was done within a short spring period to avoid seasonal changes in forest floor weight and depth and to obtain measurements representative of the spring fire season (Loomis 1965).

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